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TRAINING DECISIONS SYSTEM: OVERVIEW, DESIGN, AND DATA REQUIREMENTS

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The Air Force operates one of the world's largest job training systems, providing technical training in more than 200 enlisted specialties. In current practice, the training planning and management process is divided among several agencies. The training system includes formal resident courses conducted by the Air Training Command (ATC) at six Technical Training Centers (TTCs) and on-the-job training (OJT) performed in field units and managed by the Air Force Military Personnel Center. Additional training is provided in a variety of other settings, including ATC Field Training Detachments (FTDs), Career Development Courses, Major Command programs, mobile training teams, contractor training, and inter-Service programs and courses. A basic problem in developing overall training plans for first-term and career airmen or across Air Force career ladders is deciding what tasks to train in TTCs, FTDs, or OJT and what the proficiency levels achieved by that training should be.

The Training Decisions System research and development effort evolved from a recognition by HQ ATC and HQ USAF/DPPT that (a) independent decisions were being made by different agencies within the Manpower, Personnel, and Training (MPT) communities; (b) there was no way to proactively estimate what the impact of various training

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options would be; and (c) there were no comprehensive, readily accessible cost data regarding OJT. MPT decisions--although they are the best possible given the available information--could benefit significantly from an accurate data base and modeling capability oriented toward the macro-level decision maker.

Recent Air Force budgetary constraints have resulted in a reduced supply of money and personnel for accomplishing Air Force training. Consequently, training decisions throughout the Air Force are becoming increasingly critical, yet more difficult, because of incomplete and inadequate cost data. TDS will provide Air Force decision makers with an automated decision aid to help plan and estimate the consequences of various mixes of resident training, OJT, and field training within a career ladder. The capability to model such factors as training requirements, cost, and capacity early in Air Force training development will substantially improve the training planning and programming process within the Air Force.

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SUMMARY

The Training Decisions System (TDS) is being developed to provide a more unified and integrated approach to training programming and planning. Specifically, TDS uses information obtained from job tasks performed by airmen, combined with airman assignment information and Air Force training capacities, to determine what cost-effective training options are available.

Recent Air Force budgetary constraints have resulted in a reduced supply of money and personnel for accomplishing Air Force training. Consequently, training decisions in the Air Force are becoming increasingly critical. Furthermore, making those decisions has been made more complex by incomplete and inadequate cost data. Due to the scope and complexity of Air Force training, the challenge has been in deciding what to train (training content), where to train (appropriate training settings), and when training should occur (at what point in an airman's career). The resulting decisions, although the best possible given the information available at the time, could have benefited from a large, accurate data base to help answer these questions.

TDS is an extensive multi-year research and development effort consisting of three basic subsystems and a fourth integrating subsystem. The first subsystem, the Task Characteristics Subsystem, will provide task training modules and associated training site allocation preference data. These modules will be the prime building blocks for the other subsystems. The second subsystem, the Field Utilization Subsystem, will provide present and alternative training/personnel assignment patterns and associated preference values. These training/personnel assignment patterns will be the prime focus of analysis for the Training Decisions System. The third subsystem, the Resource/Cost Subsystem, will provide costs and capacity indicators for each task module for each training site. These costs and capacity functions will be an important input to the training optimization routines contained in the Integration and Optimization Subsystem. This subsystem will result in the integration of the three previously described subsystems. In addition, it will provide optimization software and an interactive system that will allow managers to answer "what if" questions relative to training.

PREFACE

The Training Decisions System (TDS) research and development (R&D) effort is sponsored by HQ USAF/DPPT and HQ ATC/TTXR. TDS is being accomplished under Project 7734 and executed as part of Air Force Human Resources Laboratory's (AFHRL's) responsibility to provide managerial training information to aid Air Force policy decisions.

An effort such as this can be accomplished only through the cooperative efforts of many people. Special recognition should be given to Dr. Robert Yadrick, Dr. Bruce Perrin, Mr. Ralph Knight, Mr. Steve Feldsott, Mr. Wayne Archer, and Captain Joe Filer for their significant contributions to this R&D effort. Dr. Yadrich, Dr. Perrin, and Mr. Knight, through their contributions to the development of the Task Characteristics Subsystem and the Field Utilization Subsystem, played key roles in the TDS R&D effort. Mr. Feldsott and Captain Filer's involvement with the Resource/Cost Subsystem also contributed significantly to the TDS development. Special thanks go to Mr. Wayne Archer for his hard work on all aspects of this R&D effort.

As can be seen from the author list, three geographically separated R&D organizations--AFHRL; McDonnell Douglas Astronautics, St. Louis MO; and CONSAD Corporation, Pittsburgh PA--participated to create a usable Air Force product from what was previously only a desirable concept. TDS will improve decisions of Air Force training managers while simultaneously saving valuable Air Force training dollars.

A special debt is owed to all the AFHRL Commanders, Division Chiefs, and Technical Directors who provided support and assistance. Finally, a special debt is owed to the numerous subject-matter experts from all Major Commands for their timely assistance and cooperation in this Air Force Systems Command project.

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I. INTRODUCTION

The Training Decisions System (TDS) project, started in September 1983, was developed to provide a more unified and integrated approach to training programming and planning. Being used as the basis for system development are four Air Force Specialties (AFSs) that represent a cross-section of Air Force training requirements:

1. 328X4, Avionic Inertial and Radar Navigation Systems
2. 811XX, Security/Law Enforcement
3. 423X1, Aircraft Environmental Systems
4. 305X4, Electronic Computer and Switching Systems

Due to the scope and complexity of Air Force training, the challenge to decision makers has been in deciding what to train (training content), where to train (appropriate settings), when training should occur (at what point in an airman's career), and what are the most cost-effective training options available. TDS integrates training requirements, as well as manpower and cost considerations, into a single comprehensive model.

As shown in Figure 1, TDS consists of three basic subsystems and a fourth integrating subsystem. The Task Characteristics Subsystem (TCS) provides task training modules and associated training setting preference data. The Field Utilization Subsystem (FUS) provides current and alternate training and personnel assignment patterns, and associated preference values. The Resource/Cost Subsystem (RCS) provides cost and capacity indicators for each task module for each training site. The Integration and Optimization Subsystem integrates the three previously described subsystems, and provides managers with the capability of modeling "what if" training options and deriving associated cost data. The particular purposes of each TDS subsystem will be described in detail throughout this paper, beginning with the TCS. For the reader's convenience, a Dictionary of TDS Terms is included in Appendix A.

II. TASK CHARACTERISTICS SUBSYSTEM

TCS Purpose

The TCS is a multipurpose subsystem. One purpose of the TCS is to create Task Training Modules (TTMs) using a computer-based task clustering methodology developed specifically for the TDS research and development effort by McDonnell Douglas Astronautics Company (St. Louis, MO Division) and the Air Force Human Resources Laboratory. This methodology produces the clusters of tasks, TTMs, which share similar underlying skills and knowledges, and which are commonly co-performed in accomplishing Air Force jobs. The TTMs form the basic units of analysis for the TDS and, as such, are the essential building blocks to which all subsequent information is ultimately linked. The advantages of using TTM-based data for evaluating training decisions, instead of using task-based data, are that TTMs are not susceptible to overestimating training requirements, they are replicable, they are more cost-efficient to generate, and they have been validated (Perrin, Vaughan, Yadrick, Mitchell, & Knight, 1986).

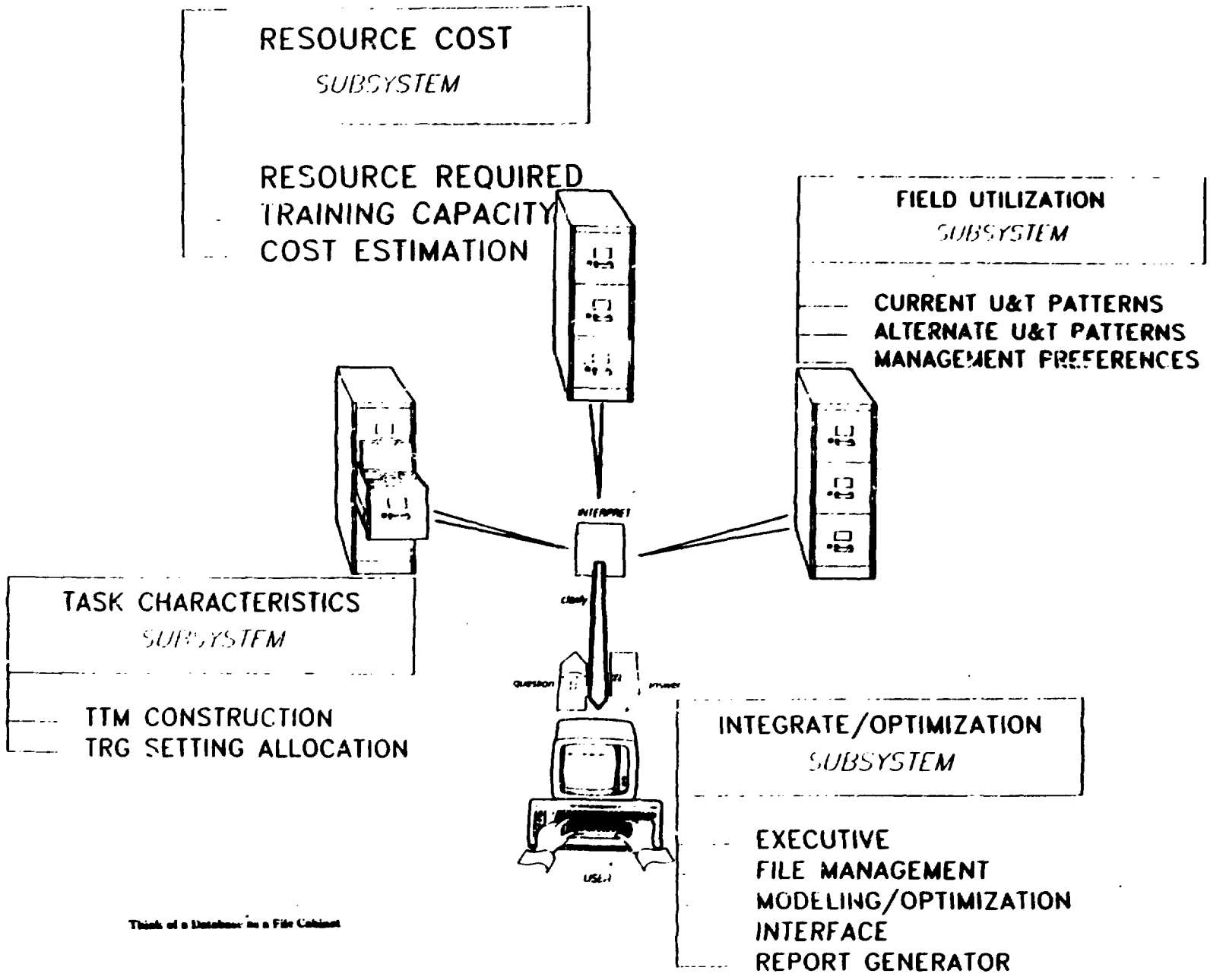

Figure 1. Training Decisions Systems (TDS).

A second function performed by the TCS is to determine the training settings (or combinations of settings) where the TTMs could be taught. This determination is necessary in order for the other TDS subsystems (described later) to develop their training-setting-related information. Another function of the TCS is to collect managerial information from which a rank-ordered list is derived based on how training managers would prefer to have TTMs allocated among alternative training settings. A final purpose of the TCS is to develop for each potential training setting three training time estimates: (a) current training time, (b) optimum training time, and (c) minimum training time (should compression of training occur).

TCS Components

The TCS is comprised of two components--a TTM Construction Component and a Training Setting Allocation Component. The TTM Construction Component produces TTMs consisting of groups of tasks that can and should be trained together. The tasks which comprise a TTM are generally grouped using iterative, multivariate statistical techniques which yield groups of tasks (clustered within a TTM) that tend to be performed together (high co-performance) in accomplishing a job. Furthermore, research has demonstrated that the tasks within a TTM do share similar skills and knowledges (Perrin et al., 1986).

The Training Setting Allocation Component gathers data concerning feasible allocations of TTMs across training settings. The allocations take into consideration variables associated with career paths such as the point in an individual's career at which certain duties will likely be performed. (This information will come from, and be described by, the next subsystem.) A savings in training dollars would result, for example, if only those duties that first-term airmen need to perform were trained together according to the corresponding TTMs. Similarly, those duties associated with second-termers or management personnel would be taught according to the TTMs applicable to the point in their careers when that knowledge is needed.

Consequently, the Training Setting Allocation component will ensure that training is given at a logical time, at a logical place, to people who have a need to use the knowledge that is conveyed to them. The final products of the allocation component are the determination of (a) the most preferred training setting, (b) alternative training settings, and (c) which training setting yields the maximum gain in proficiency (i.e., maximum effective training).

III. FIELD UTILIZATION SUBSYSTEM

FUS Purpose

The FUS will address the personnel flow patterns through a particular AFS. It will also provide feasible alternative flow patterns. Specifically, the FUS will perform the following functions:

1. Describe current and alternative Utilization and Training (U&T) patterns wherein airmen move (or might move) through various jobs, training states,[1] and proficiency states.[2] Thus, a particular stream of successive job and training states will represent a specific empirically developed career path from Basic Military Training through AFS jobs and associated training

[1]A training state is a particular example of a training setting. For example, an Air Training Command resident course taught in a classroom setting exemplifies a training state.

[2]A proficiency state refers to how fully trained the person is on each TTM as he/she progresses through the training program.

states. In the majority of cases, the FUS considers only movement within an AFS; however, in the event of cross-training, movement out of and into an AFS will also be considered.

2. Determine the training requirements and proficiency state requirements for jobs (in terms of the TTMs comprising those jobs). Alternative jobs, both existing and hypothetical, will be considered in this context in order to provide managers with a comprehensive view of training requirements and proficiency state requirements.

3. Measure management preferences for different U&T patterns, as well as the current U&T pattern. This requires that current and alternative U&T patterns be represented to managers in a clear manner, such that the implications of choosing alternative patterns are easily understood in terms of their potential impacts on the manpower, personnel, and training (MPT) communities.

FUS Components

The FUS has three major components: Current U&T Pattern Component, Alternate U&T Pattern Component, and Management Preferences Component.

The Current U&T Pattern Component will produce a description of the U&T pattern that currently exists in the AFS. This established U&T pattern provides decision makers with an important starting point from which alternative options can be explored.

The Alternative U&T Pattern Component will produce descriptions of alternative U&T patterns of potential interest to managers concerned with the specialty. Applicable data are extracted from the Pipeline Management System, the Uniform Airman Record, and AFR 50-5, as well as through numerous interactions with training managers, functional managers, and field representatives.

Finally, the Management Preferences Component will gather data concerning managers' preferences among the current and alternative U&T patterns developed in the first two components. In sum, the U&T patterns will be derived by using a combination of retrospective (historical) and prospective (managers' expectations based on current realities) data to ensure that an accurate data base exists, and that this information is accessible for the TDS integrated decisions system.

IV. RESOURCE/COST SUBSYSTEM

RCS Purpose

The RCS serves three distinct, yet interrelated purposes. One purpose of the RCS is to determine the types and amounts of resources required to provide training on each TTM in each training setting, and to estimate the amounts of those resources available for use in providing training at various sites.

A second purpose is to estimate the capacities of individual sites or units to accommodate varying amounts of training, on varying combinations of TTMs, in various training settings. Based on estimates of the training capacity at each site, the capacities of larger organizational units within the Air Force (e.g., bases, Major Commands, the entire Air Force) can be calculated.

A third function of the RCS is to estimate the variable costs incurred in providing training on individual TTMs in particular training settings. Using these elemental cost estimates,

estimates of the variable costs of providing specific amounts of training, on particular combinations of TTMs, in various training settings can be developed.

RCS Components

The RCS consists of three major components--a Resource Requirements Component, a Training Capacity Component, and a Cost Estimation Component (Rueter, Vaughan, & Feldsott, 1987).

The Resource Requirements Component will perform five functions. First, it will determine the specific types of resources that are required in order to provide training on each TTM. Next, it will estimate the quantity of each identified resource required for performing training on each TTM in each training setting. Third, it will produce compiled listings of these estimated resource types and quantities based on how they will affect variable training costs and training capacities. Fourth, it will estimate the quantities of each of those types of resources that are available at various training sites. Finally, it will identify an appropriate set of representative training sites for the AFS under consideration.

In performing the above functions, the Resource Requirements Component will use as inputs the TTM definitions and estimates of training times for individual TTMs in the different training settings developed in the TCS subsystem. It will also use preliminary lists of the type of resources required for training each TTM, compiled from standard Air Training Command documents. Based on these inputs the Resource Requirements Component will develop the basic data used in the estimation of training capacities and training costs within the other two components of the RCS, respectively.

The Training Capacity Component will derive estimates of the individual site's capacity to provide training on different combinations of TTMs to specified numbers of personnel. The inputs to this component consist of: (a) specifications of TTM combinations and training volumes that are compatible with various U&T patterns (which were derived from the FUS), (b) an estimate of the amounts of specific resources required for the provision of training on each TTM in each training setting, and (c) an assessment of the availability of those resources at each representative site for providing training in the AFS under consideration.

The Cost Estimation Component will develop estimates of the variable cost of providing training on each TTM in each training setting. Based on these estimates, it will then compute estimates of the variable costs of providing training to different numbers of personnel on different combinations of TTMs in different settings. The inputs of this component include: (a) specifications of TTM combinations and training volumes compatible with various U&T patterns obtained from the FUS; (b) estimates of the amounts of specific resources required for providing training on each TTM in each training setting (obtained from the Resource Requirements Component of the RCS); and (c) unit cost factors for the different types of resources (obtained from various Air Force data sources). Consequently, by applying the unit cost factors to the estimated resource requirements and amount of training required, this component will derive estimates of the variable costs of conducting training, in any training setting, for any combination of TTMs.

V. INTEGRATION OPTIMIZATION SUBSYSTEM

The Integration Optimization Subsystem (IOS) will combine the results of the TCS, FUS, and RCS to develop integrated reports for Air Force decision makers. It will contain optimization procedures that will provide analytic capabilities for deriving preferred training allocations.

The IOS can be conceptualized as that portion of a large data base which allows a specific data element to be called up from its row and column to become part of an equation, used in conjunction with another data element (also called up from its row and column), or manipulated in some manner to provide answers to questions. The modeling aspects of TDS allow the appropriate information to be extracted from the data base and used appropriately in answering "what if" MPT questions. Specifically, the IOS serves the following purposes:

1. Implements a model that describes relationships among TDS variables.

2. Provides access to optimization routines that provide desired information to TDS users.

3. Provides linkages among all of the TDS subsystems, the TDS system data base (containing subsystem outputs), and user-generated commands that control specific IOS operations.

IOS Components

In order for the multipurpose IOS to perform its functions, the following components have been created to subdivide the workload:

1. An Executive Component which coordinates and schedules the operations of the other IOS components.

2. A User Interface Component that presents the user with TDS options, and responds to user-generated prompts that invoke these options.

3. A Modeling and Optimization Component that combines user inputs into a mathematical model for analysis purposes and that includes a library of optimization routines pertinent to TDS applications.

4. A File Management Component that receives files from subsystem components, optimization routines, or external sources, and constructs the data files used by the IOS subsystem components or optimization routines.

5. A Report Generator Component that produces outputs at a level of detail selected by the user for a specific TDS application.

Management reports will be the major outputs from the IOS. These reports will include information that is relevant to the question being asked, the particular AFS under review, current and alternate training settings, and cost information associated with these training settings. These management reports will also contain the results of the optimization analysis. These results will be available in several layers of detail. One level of detail could be generated for executive review (e.g., to determine the suitability of the TTM-to-setting allocations). A greater level of detail could be produced to identify TTM-to-setting assumptions for field implementation.

VI. CONCLUSION

Historically, it has been difficult to assess training decisions until a sufficient amount of time has elapsed to determine the effectiveness of the decision. Furthermore, making this determination was made more complex by incomplete and inadequate cost data. Recent Air Force budgetary constraints have resulted in a reduced supply of money and personnel for accomplishing

Air Force training. Consequently, training decisions in the Air Force are becoming increasingly important.

In sum, TDS will provide Air Force decision makers with an automated decision aid to help optimize the mix of resident training, on-the-job training, and field training within an AFS. The capability to model such important factors as training requirements, cost, and capacity early in Air Force training development will save time and money, and result in effective training decisions based on accurate and timely information.

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APPENDIX A: TRAINING DECISIONS SYSTEM DICTIONARY

Alternative Utilization and Training (U&T) Pattern--A U&T pattern which does not now exist in a specialty but which is of interest to management.

Co-performance--Tasks are co-performed if they are done by the same group of people, although not necessarily at the same time.

Current Utilization and Training (U&T) Pattern--The U&T pattern which now exists in a specialty.

Field Utilization Subsystem (FUS)--The Training Decisions System subsystem concerned with building current and alternative U&T pattern models of a specialty and assessing managers' preferences for those U&T patterns.

Full proficiency--Meets minimum acceptable job performance requirements on a Task Training Module.

Integration and Optimization Subsystem (IOS)--The Training Decisions System subsystem which provides "what if" modeling optimization capabilities and which handles user interfaces.

Job--A group of airmen who generally do the same tasks. Job types as identified in the USAF Occupational Measurement Center occupational surveys are jobs by this definition.

Modeling--Predicting what would happen to certain variables if others have hypothetical values.

Optimization--Finding values for certain variables which optimize (maximize or minimize) other variables.

Resource/Cost Subsystem (RCS)--The Training Decisions System subsystem concerned with assessing training costs, resource requirements, and capacities.

Task--A task from the USAF Occupational Measurement Center occupational survey task list in a specialty. A typical specialty task list contains 500 to 1,000 tasks.

Task Characteristics Subsystem (TCS)--The Training Decisions System subsystem concerned with building task training modules and gathering data concerning training times on such task training modules in various training settings.

Task Training Module (TTM)--A group of tasks which it may be advantageous to train together because the tasks are performed by the same group of people, share similar skills and knowledges or training resources, or, generally, because economies of effort may be achieved.

Training allocation--A distribution of training on a Task Training Module across training settings or states, specified in terms of training times or proficiency increases.

Training capacity--The number of trainees that can be accommodated at a particular training site under a set of specified training allocations involving the site.

Training cost--The annual recurring cost of providing training.

Training Decisions System (TDS)--A computer-based decision support system for assisting managers in making training resource allocation decisions.

Training setting--A generic means of delivering training (e.g., classroom, correspondence course, on the job).

Training site--A set of organizations within which training resources may be shared or reallocated. Training sites are usually geographic locations (e.g., bases) and organizations (e.g., technical training branches).

Training state--Specific training course (e.g., the 32RX4 Airman Basic Resident course, the 81150 Career Development Course, on-the-job training at a particular unit covering a particular set of task training modules). Usually, a training state is in a particular training setting (e.g., a Career Development Course is in the correspondence course setting), although a training state could involve multiple settings.

Transition probability--The likelihood of moving from a particular job or training state to another particular job or training state. Transition probabilities reflect the flow of airmen from job to job throughout their careers.

Utilization and Training (U&T) Pattern--A dynamic model reflecting the movement of airmen through jobs and training in their careers for a particular specialty. A U&T pattern is made up of jobs, training states (both described by task training modules), and transition probabilities.